The Jahn-Teller effect plays a crucial role in multiferroics

For decades physicists have been interested in the study of the Jahn-Teller (JT) effect, which gives rise to symmetry breaking of orbitally degenerate ground states in non-linear molecules and solids. The JT effect is known to induce low-symmetry structural distortions in octahedrally coordinated transition-metal ions like Mn3+ and Cu2+, giving rise to additional splitting of 3d orbitals. This effect is also responsible for the occurrence of interesting physical properties in materials like superconductivity, insulating ferromagnetism or colossal magnetoresistance, and also governs diverse critical phenomena related to insulator-metal transitions or changes from ferromagnetic to antiferromagnetic behaviour or vice versa.

CuWO4 is a single-phase multiferroic material, which simultaneously exhibits ferroelasticity and antiferromagnetism. Javier Ruiz-Fuertes and his colleagues from the University of Valencia and the University of Cantabria have squeezed CuWO4 crystallites between two diamonds and carried out single-crystal x-ray diffraction, extended x-ray absorption fine structure, and optical absorption experiments. The study has demonstrated that the CuO6 octahedra react against compression to preserve the JT distortion. Pressure progressively reduces the JT distortion up to 9 GPa, above which the elongated O-Cu-O direction abruptly flips to another direction for accommodating the JT-distorted CuO6 octahedra. This process yields structural transition to higher symmetry phase that presumably produces a change in the magnetic order. The correlation study between the structural and the spectroscopic data carried out in CuWO4 has allowed the research team to obtain first experimental determinations of the JT-related electron-lattice coupling coefficients for Cu2+, in the same system, for two different crystal structures. The observed structural variations do modify the exchange paths between Cu2+ ions in CuWO4 and consequently its magnetic behaviour. Thus, the reported findings provide experimental support to understand magnetic transitions in exchange-coupled transition-metal compounds mediated by the JT effect.